

THEREFORE I CLAIM

1. A pedal- and motor-assist power system for a bicycle which has, at least one drive wheel, and a bicycle frame with front and rear ends, said system comprising:

- 5 a) a pedal section comprising:
 - i. first and second pedal members;
 - ii. a crank shaft connecting the pedal members;
 - iii. a crank housing in which the crank shaft is located;
- 10 b) a sprocket section having a chain-and-sprocket drive connection to said drive wheel;
- c) a motor section;
- d) a speed-reducing gear section connecting to said motor section and having a gear section drive output;
- 15 e) a power assist drive section comprising a power assist drive member having a power-assist drive connection between the gear section drive output and the sprocket section;
- f) said system being characterized in that the sprocket
- 20 section has a first pedal overrunning drive connection with said pedal section and the power-assist drive connection has a second overrunning drive connection;
- whereby said bicycle is able to operate in four operating modes, namely:
- 25 i. a power-assist mode where a bicycle rider is pedaling to supply power, and the power-assist section is providing power;

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- ii. a pedal-only mode where power is being supplied solely by pedaling the bicycle;
 - iii. the power-assist-only mode where the bicycle rider is not providing power by pedaling, but power is supplied by the power output section; and
 - iv. a coasting no-power mode where the bicycle is traveling with the pedal section stationary, and no power is being supplied by either the pedal section or the power-assist drive section.

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2. The system as recited in claim 1, wherein said power-assist drive member is concentrically mounted around said crank shaft.

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3. The system as recited in claim 2, wherein said power-assist drive member has a fixed drive connection to the sprocket section and the power-assist-overrunning drive connection is between the power-assist drive member and the gear section drive output.

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4. The system as recited in claim 2, wherein said sprocket section and said first pedal member are nearer to the second side of the frame, and said power-assist drive member has a second end portion that connects to said sprocket drive, and a first end portion that is nearer to the first side of the frame, said first end portion connecting through the power-assist overrunning drive connection to the gear section drive output.

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5. The system as recited in claim 2, wherein said power-assist drive member has a tubular configuration with first and second power-assist member portions on opposite sides of the bicycle, said

power-assist drive member and said crank housing being positioned concentrically around a center axis of said crank shaft.

5 6. The system as recited in claim 5, wherein the second end portion of the power-assist drive member has a fixed power connection to the drive sprocket, and the first end portion of the power-assist drive member connects with the gear section drive output through said power-assist overrunning drive connection.

10 7. The system as recited in claim 6, wherein said power-assist drive member is rotatably mounted on bearings that have an operative load-bearing relationship with said crank housing, and said crank shaft is at least in part supported by bearings in load-bearing relationship with said power-assist drive member so that said power-assist drive member and said crank shaft are rotatable relative to one another.

20 8. The system as recited in claim 1, wherein said motor is a high-speed motor that is driven by petroleum-based fuel and operates at least 1000 RPM, said motor having a sheave-and-belt drive connection with said speed-reducing gear section, whereby tension forces exerted on the sheave-and-belt drive from the motor to the speed-reducing gear section are substantially less than forces imposed in the drive connection between the speed-reducing gear section and the power-assist drive member.

9. The system as recited in claim 8, wherein said motor is located proximate to an upper rear portion of said frame, and said speed-reducing gear section is located closely adjacent to said crank

housing, so that a first distance of the motor to the speed-reducing gear section is substantially greater than a distance from the speed-reducing gear section to the crank housing,

5 10. The system as recited in claim 1, wherein said motor is an electric motor which is mounted closely adjacent to said speed-reducing gear section.

10 11. The system as recited in claim 1, wherein said speed-reducing gear section comprises a center drive shaft having an offset drive portion on which is rotatably mounted an orbiting cluster gear section that rotates in an orbiting motion to produce a rotational speed reduction ratio at least as great as about 20:1.

15 12. The system as recited in claim 11, wherein the rotational speed reduction is at least as great as 40:1.

20 13. A method of installing a pedal- and motor-assist power system in a bicycle where said bicycle comprises a bicycle frame with at least one drive wheel, and a crank housing connected to the frame, said method comprising:

- 25 a) positioning a power-assist drive member and a crank shaft in the crank housing with first and second end portions each of the power assist drive member and of the crank shaft being adjacent to first and second end portions of the crank housing;
- b) providing a speed reducing gear section and a sprocket section, and making a drive connection from the speed reducing gear section through the power-assist drive

member to the sprocket section, with this drive connection being an overrunning drive connection;

- c) providing an overrunning drive connection operably connected between said crank shaft and said sprocket connection;
- d) attaching first and second pedal members to the first and second end portions of the crank shaft;
- e) connecting a high speed motor to said speed reducing gear transmission.

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14. The method as recited in claim 13, wherein said method further comprises providing said speed reducing gear section and said power-assist drive member as a preassembled unit, and said power-assist drive member is positioned in said housing with said power-assist drive member being connected to the speed reducing gear section.

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15. The method as recited in claim 14, wherein the method further comprises interconnecting said speed reducing gear section to said power-assist drive member by providing a housing/connecting structure that has an intermediate chamber, with said speed reducing gear section and said power-assist drive member having a drive connection located in said intermediate chamber.

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16. The method as recited in claim 13, wherein said method further comprises installing end adapters in first and second ends of said crank housing and rotatably supporting said power assist drive member by said adapters.

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17. The method as recited in claim 13, wherein said method further comprises providing the overrunning drive connection for the speed reducing gear section through to the sprocket section by providing an overrunning clutch member operatively connected
 5 between the speed reducing gear section and the first end of the power-assist drive member.

18. A method of operating a bicycle by pedaling and also utilizing power-assist, said method comprising:

- 10 a) pedaling first and second panel members to rotate a crank shaft to in turn drive a sprocket section of the bicycle through an overrunning drive connection;
- b) providing power-assist by operating a motor at relatively high rotational speed to provide power input to a speed
 15 reducing gear transmission to rotate a power-assist drive member located in a crank housing of the bicycle to in turn transmit drive power to said sprocket section, with said speed reducing gear section providing driving force through said power-assist drive member and to said
 20 sprocket by means of an overrunning drive connection;

whereby said bicycle is operating in four operating modes, namely:

- i. a power-assist mode where a bicycle rider is pedaling to supply power, and the power-assist section is providing power;
- 25 ii. a pedal-only mode where power is being supplied solely by pedaling the bicycle;
- iii. the power-assist-only mode where the bicycle rider is not providing power by

pedaling, but power is supplied by the power output section; and

- iv. a coasting no-power mode where the bicycle is traveling with the pedal section stationary, and no power is being supplied by either the pedal section or the power-assist drive section.

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19. The method as recited in claim 18, wherein said
 10 overrunning drive connection from the speed reducing gear section through the power-assist drive member to the sprocket section is provided by operating an overrunning clutch member operatively connected between the speed reducing gear section and the power-assist drive member.

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20. A retrofit assembly to provide for a bicycle a power-assist drive system, said retrofit assembly comprising at least:

- a) a motor section adapted to be mounted to the bicycle;
- b) a speed reducing gear section adapted to be mounted to
 20 the bicycle and also adapted to be operatively adapted to the motor section, said speed reducing gear section having a gear section drive output;
- c) a power-assist drive section comprising a tubular power assist drive member configured and adapted to be
 25 positioned rotatably in said crank housing and also to receive therein a crank shaft;
- d) a first pedal overrunning clutch member adapted to be operatively connected between a sprocket section of the bicycle and a pedal section of the bicycle;

- e) a second power-assist overrunning clutch member adapted to be operatively positioned between the speed reducing gear section and the power-assist drive member;

5 whereby, the retrofit assembly is able to be operatively installed in said bicycle to enable said bicycle to operate in four operating modes, namely:

- 10 i. a power-assist mode where a bicycle rider is pedaling to supply power, and the power-assist section is providing power;
- ii. a pedal-only mode where power is being supplied solely by pedaling the bicycle;
- 15 iii. the power-assist-only mode where the bicycle rider is not providing power by pedaling, but power is supplied by the power output section; and
- iv. a coasting no-power mode where the bicycle is traveling with the pedal section stationary, and no power is being supplied
- 20 by either the pedal section or the power-assist drive section.